



Occidental Chemical Corporation

OFF-SITE INVESTIGATION WORK PLAN

**Buffalo Avenue Plant
Module III - Corrective Action and
Waste Minimization Requirements
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CONESTOGA-ROVERS & ASSOCIATES

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1.0 INTRODUCTION

Based on the data collected in conjunction with the Supplemental Data Collection Program (SDCP) for OxyChem's Buffalo Avenue Plant, it is evident that chemicals are present in the overburden and bedrock hydrogeologic regime at the Plant property boundaries. As a result, the SDCP requires that an Off-Site Investigation (OSI) be undertaken. The purpose and scope of the proposed investigation are:

- To determine the magnitude and extent of site-related chemical presence in the overburden and bedrock groundwater regimes in the off-site areas which are downgradient of those areas along the plant boundary that exhibit the highest chemical concentrations (excluding the river boundary); and
- To evaluate the extent to which the New York Power Authority (NYPA) Power Conduit drains, the Falls Street tunnel and the Energy Boulevard drain tile system influence the off-site migration of chemicals in the groundwater.

In order to fulfill the purpose of the OSI, the study will focus on groundwater hydraulic and chemical data collection. Chemical migration via groundwater flow is the primary mechanism by which chemicals have left the Plant Site and is therefore the appropriate pathway to be investigated. Since this data will be collected in areas which may have been impacted by off-site chemical sources, caution will be exercised in evaluating the collected data to minimize such interferences. The consistency

of the flow and chemical distribution patterns identified will be instrumental in identifying the contributions attributable to the OxyChem Buffalo Avenue Plant.

The major components of the OSI will include:

- i) installation and hydraulic testing of three bedrock well nests, each consisting of three bedrock wells installed to various depths;
- ii) installation and hydraulic testing of five shallow bedrock wells;
- iii) installation of nine overburden wells; and
- iv) chemical and hydraulic monitoring of the above installations.

Depending upon the results of the investigation, additional study may be needed.

2.0 STUDY AREA

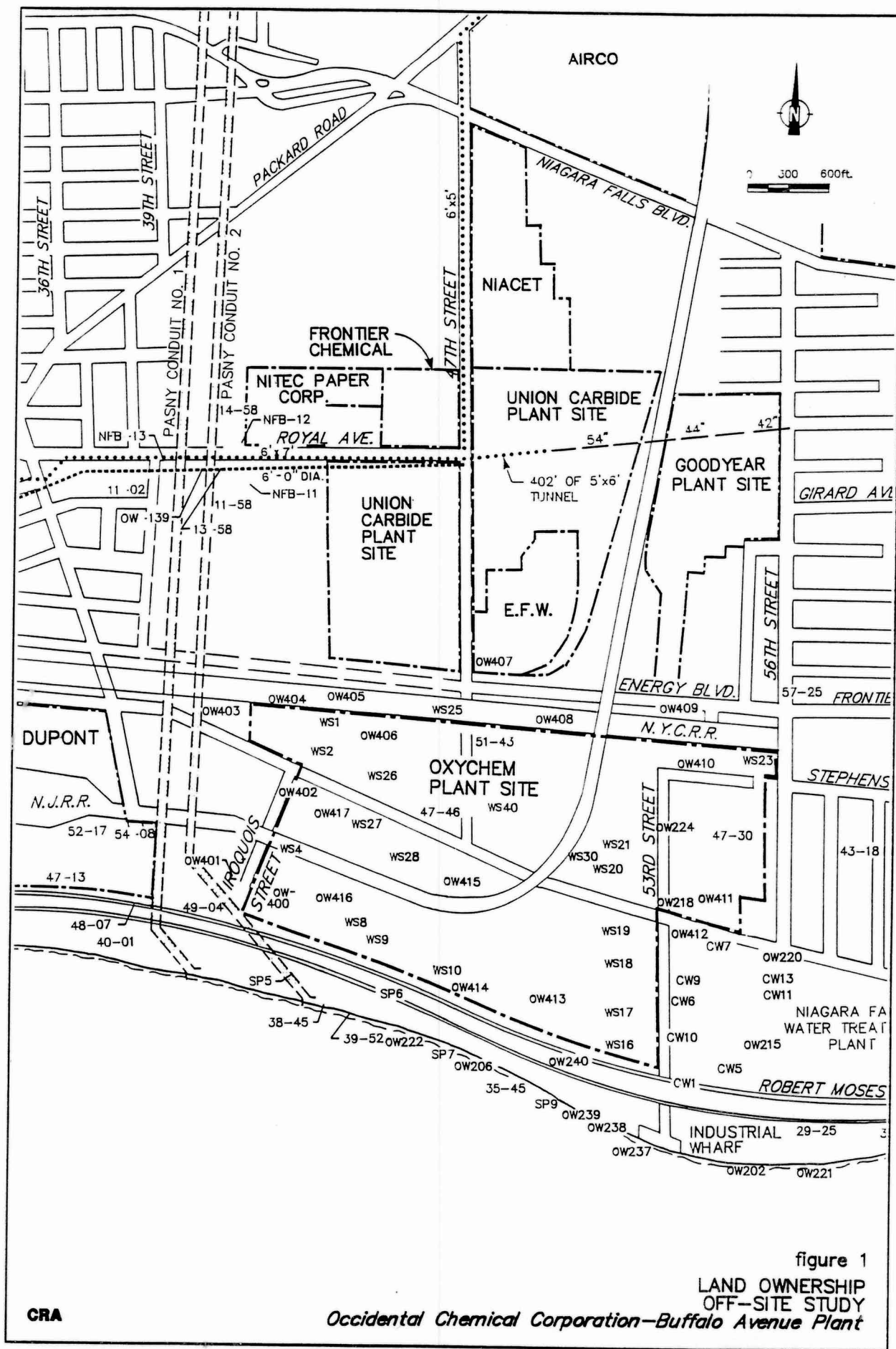
2.1 STUDY AREA LOCATION

The study area is located to the north and west of the Buffalo Avenue Plant Site. The area of investigation is located downgradient (i.e. bedrock wells) or adjacent to (i.e. overburden wells) areas that exhibited chemical presence along the Plant boundary as defined by the SDCP. The selection of the areas north and west of the Plant as the area requiring further study is based upon the results of the SDCP sampling programs. These programs have identified the north and west areas to be the most likely receptors of chemical flux from the Plant.

Considering that there is elevated chemical presence along the northern and western Plant boundaries and also that there are northerly and westerly components of groundwater flow across these boundaries, it is appropriate that the areas adjacent to these boundaries be selected as the location for the off-site study. Figure 1 presents the location of the Plant in context of the surrounding areas and property ownership.

2.2 PREVIOUS STUDIES AND FINDINGS

Most of the early work on groundwater migration in the Niagara Falls area focussed on groundwater resource studies (e.g., Johnston, 1964). More recently, studies have been conducted by the United States Geological Survey (USGS) (Yager and Kappel, 1987) on the regional hydraulic



parameters of the Lockport Group. As well, Environment Canada (Novakowski and Lapcevic, 1989) has conducted studies on the Canadian side of Niagara Falls to determine the regional flow in the underlying Silurian and Ordovician bedrock. In addition, several industries (OxyChem, Dupont, Olin, etc.) in the area have contributed to the understanding of the regional hydrogeology through investigations conducted in their specific areas. The following paragraphs of this report presents regional data pertaining to the hydraulic properties and groundwater flow characteristics in the various geologic units.

Groundwater sources are not extensively utilized in the Niagara Falls area due to the naturally poor water quality and the proximity of the Niagara River.

The overburden materials in the Niagara Falls area are not important sources of water. For the most part, the overburden materials consist of fine-grained lacustrine and glacial deposits. Given the low hydraulic conductivities of these materials they are considered regional aquitards and groundwater flow within these units is minimal. However, near the Niagara River, a thin layer of more permeable silty sand and areas of fill overlie the aquitard and provide a pathway for lateral migration.

The major aquifer in the Niagara Falls area is the Lockport Group (Johnston, 1964). Groundwater occurs within the Lockport Group in the following types of openings:

- i) bedding joints;
- ii) vertical joints; and
- iii) small cavities and vugs.

Johnston (1964) identified that bedding joints are the primary conduits of groundwater flow through this bedrock unit. The bedding plane fractures have been found to be areally extensive over several miles. Several waterbearing bedding planes have been identified in the Niagara Falls area.

A zone of high yielding wells in the Lockport Group was identified by Johnston (1964). The zone, which is located approximately two miles from the Falls, is approximately one-half mile wide and trends north-eastward. Johnston attributed the high yields to induced infiltration. Recent geophysical investigations have shown that this highly transmissive zone is also related to more extensive vertical fracturing (Yager and Kappel, 1987). The vertical fractures interconnect the horizontal bedding fractures, resulting in higher hydraulic conductivities.

In general, regional groundwater flow in the Lockport Group is toward the Niagara River Gorge. Recharge occurs at the Niagara Escarpment and groundwater flows southwestward toward the Niagara River. Near the City of Niagara Falls, groundwater flow has been altered by several man-made structures. The Niagara Power Plant reservoir is a source of recharge to the Lockport Group, while the NYPA Power Conduits act as a source of groundwater discharge (Miller and Kappel, 1987). Figure 2 presents the generalized groundwater flow conditions for the City of Niagara Falls.

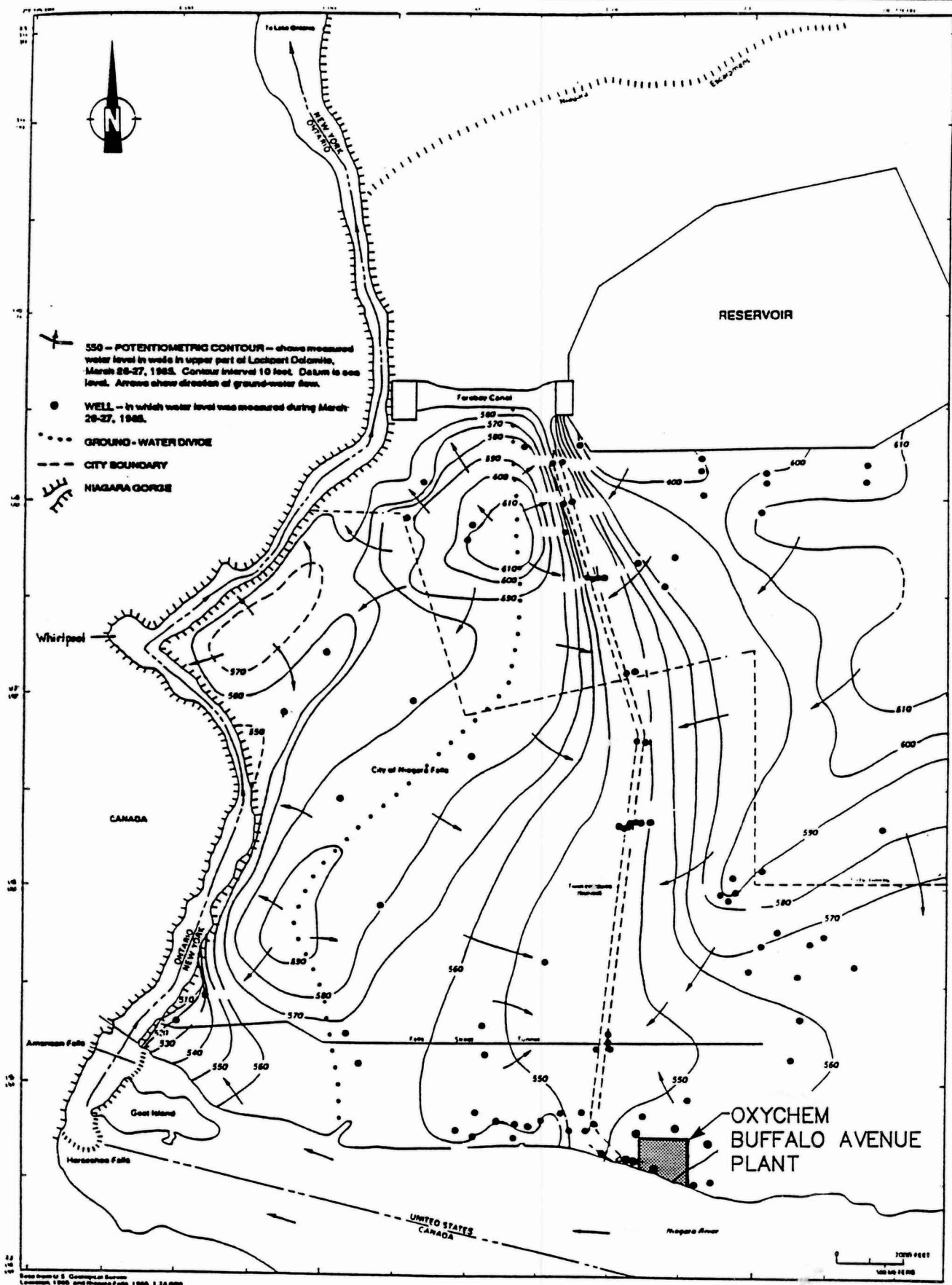


Figure 2. Generalized potentiometric surface and direction of ground-water flow in the upper part of the Lockport Dolomite. (Modified from Miller and Kappel, 1987.)

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Investigations into the hydraulic characteristics of the Clinton and Medina Groups are limited. Environment Canada determined that groundwater flow in the Clinton/Upper Medina Group is minimal in direct comparison to the Lockport Group. The flow directions were found to be vertically upwards, except near the Niagara River Gorge where stress relief fracturing has enhanced horizontal and downward vertical hydraulic conductivities.

A zone of low hydraulic conductivity was identified at the Lower Medina/Upper Queenston contact. Groundwater flow in this zone is in a lateral direction, likely northward toward the Niagara River Gorge.

The information from these studies has been supplemented by the SDCP and OxyChem compilations of data from the area near the Plant to better understand the conditions in the proposed OSI area. The following sub-sections identify the generalized conditions found at the Plant and in the proposed OSI area. The data compilations include both hydrogeologic and chemical data. During the SDCP, the samples collected were analyzed for the list of parameters noted on Table 1.

i) OVERBURDEN REGIME

While the Site overburden groundwater flow pattern is generally from the northern Plant boundary to the south towards the Niagara River, there are other factors which influence localized groundwater flow.

TABLE 1
SITE SPECIFIC INDICATORS
BUFFALO AVENUE PLANT SDCP

<i>Analytes</i>	<i>Units</i>	<i>Method Detection Level</i>
pH		
Specific Conductance	umhos	1
Phosphorus, Total Soluable (As P)	µg P/L	10
Arsenic	µg/L	53
Mercury	µg/L	0.4
Lead	µg/L	42
Toluene	µg/L	1
2-Chlorotoluene	µg/L	1
4-Chlorotoluene	µg/L	1
2,2/2,5-Dichlorotoluene	µg/L	1
2,6-Dichlorotoluene	µg/L	1
2,3/3,4-Dichlorotoluene	µg/L	1
2,3,6-Trichlorotoluene	µg/L	1
2,4,5-trichlorotoluene	µg/L	1
Benzene	µg/L	1
Chlorobenzene	µg/L	1
1,2-Dichlorobenzene	µg/L	1
1,3-dichlorobenzene	µg/L	1
1,4-dichlorobenzene	µg/L	1
1,2,3-Trichlorobenzene	µg/L	1
1,2,4-Trichlorobenzene	µg/L	1
1,2,3,4-tetrachlorobenzene	µg/L	1
1,2,4,5-tetrachlorobenzene	µg/L	1
Hexachlorobenzene	µg/L	1
Trichloroethylene	µg/L	1
Tetrachloroethylene	µg/L	1
2-Chlorobenzotrifluoride	µg/L	1
4-Chlorobenzotrifluoride	µg/L	1
2,4-dichlorobenzotrifluoride	µg/L	1
3,4-dichlorobenzotrifluoride	µg/L	1
Hexachlorobutadiene	µg/L	1
Hexachlorocyclopentadiene	µg/L	1
Octachlorocyclopentene	µg/L	1
Perchloropentacyclohexane (Mirex)	µg/L	1
2,4,5-Trichlorophenol	µg/L	10
a-Hexachlorocyclohexane	µg/L	1
b-Hexachlorocyclohexane	µg/L	1
g-Hexachlorocyclohexane	µg/L	1
d-Hexachlorocyclohexane	µg/L	1
Benzoic Acid	µg/L	100
2-Chlorobenzoic Acid	µg/L	100
3-Chlorobenzoic Acid	µg/L	100
4-Chlorobenzoic Acid	µg/L	100
Chlorobenzoic Acids, Total	µg/L	100
Chlorendic Acid	µg/L	200
Total Organic Carbon (TOC)	mg/L	1
Total Organic Halides (TOX)	µg/L	50

The most prominent of these factors is the presence of a vast network of underground sewers. Most of these sewers are old and are therefore expected to allow groundwater to infiltrate the pipes. In addition to this, there are other manmade systems which have been installed at and in the vicinity of the Plant for the purpose of dewatering the overburden soils. One such system is the Energy Boulevard Drain Tile System which was designed to intercept groundwater before it could enter the sewer system along Energy Boulevard. Another dewatering system is the drainage network that was constructed along the NYPA Power Conduits installed near the western Plant property boundary. The combination of these various dewatering mechanisms results in considerable non natural influence on the groundwater table. Consequently, most of the overburden groundwater is trapped within the grid of sewers and extraction systems. There is little opportunity for significant unabated groundwater flow.

Plan 17 of the Draft Final SDCP Report (copy of plan is enclosed) presents the overburden groundwater contours generated from a set of water level data collected in February 1989. The pattern identified is consistent with the isolated mounding and pockets that would be expected based upon the myriad of water sources and sinks acting on the overburden groundwater flow regime. The Plant overburden groundwater regime and geologic stratigraphy is detailed in the report entitled "Overburden Summary Report - December, 1989".

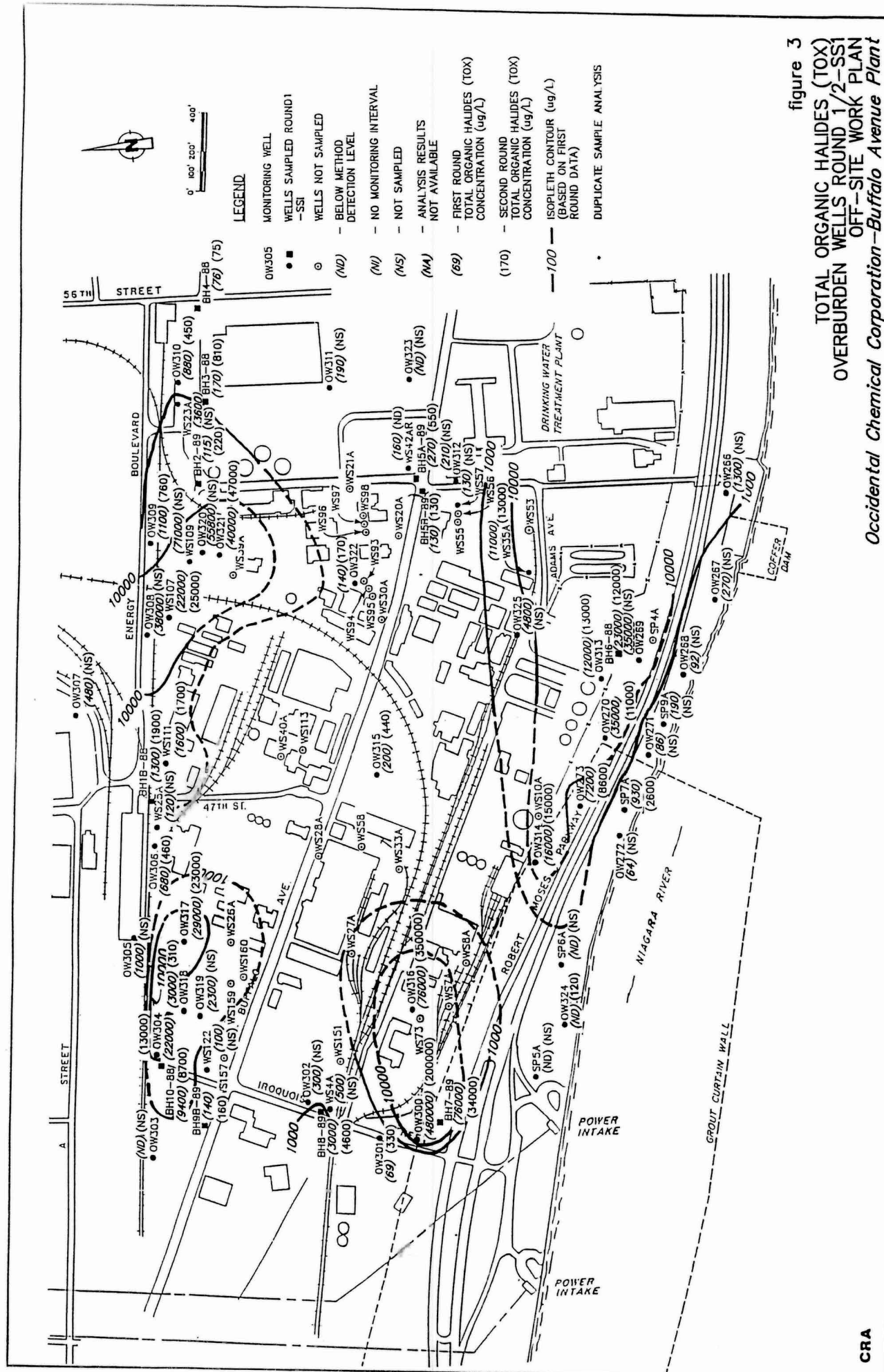
Additional SDCP reports which discuss the overburden chemistry and hydrogeologic findings are:

- General Parameter Survey Program (February 1989);
- Overburden Well Selection for Round 2 SSI Sampling (December 1989);
and
- Overburden and Bedrock Groundwater Analytical Results - Summary of Round 2 SSI Sampling (May 1990).

Figures 3 and 4 summarize the Total Organic Halides (TOX) and Total Organic Carbon (TOC) chemistry observed in the overburden groundwater samples collected during the two SSI groundwater sampling rounds performed at the Buffalo Avenue Plant as part of the SDCP. Generally, TOX and TOC presence in the overburden groundwater regime reflects past operational activities at the Plant. Areas of elevated TOX and TOC presence are noted adjacent to the Plant boundaries to the north, northwest and west.

The north boundary TOX/TOC presence observed along Energy Boulevard is addressed by the Energy Boulevard Drain Tile System which acts as an effective barrier to further northerly chemical migration. Although overburden groundwater to the west of the Plant Site is expected to be collected by the NYPA Power Conduit's dewatering system, it is not anticipated that the chemical loading from the groundwater exiting the Western Plant Boundary is substantial .

The overburden off-site investigation will be conducted in the areas north, northwest and west of the Plant Site in response to the



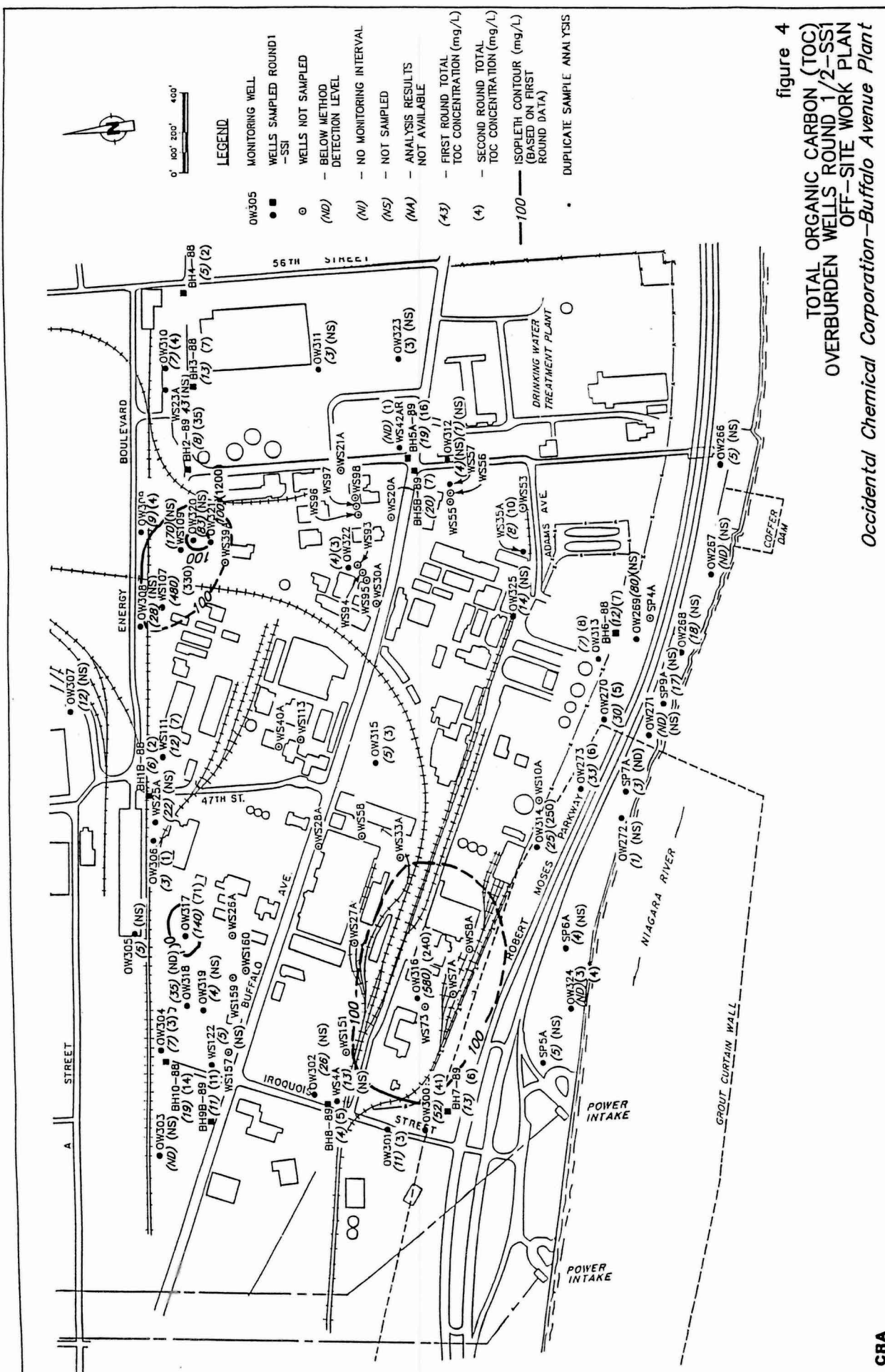


figure 4
TOTAL ORGANIC CARBON (TOC)
OVERBURDEN WELLS ROUND 1/2-SS1
OFF-SITE WORK PLAN
Occidental Chemical Corporation-Buffalo Avenue Plant

proximity of the overburden elevated chemical presence to these Plant boundaries. To complete the evaluation of overburden hydraulic and groundwater chemistry conditions, overburden monitoring wells will be installed along the west and north property boundaries .

ii) BEDROCK REGIME

Previous SDCP reports which describe the bedrock chemistry and hydrogeologic findings are:

- Overburden and Bedrock Groundwater Analytical Results
 - Summary of Round 2 - SSI Sampling (May 1990); and
- Bedrock Information Summary Report (March 1990).

The bedrock groundwater flow under the Plant Site is in a northwest/westerly direction as a result of the NYPA Power Conduit's dewatering effect and groundwater recharge from the Niagara River. Figure 5 presents the bedrock groundwater contours generated from a set of regional water level data collected in October/November 1989. The regional groundwater pattern is clearly defined with flow being drawn from all directions toward the intersection of the NYPA Power Conduits and the Falls Street Tunnel. Both of these systems have been historically and continue to act as a sink for groundwater flow and have influenced the bedrock groundwater flow patterns over the entire area depicted on Figure 5.